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(54) Magnetic amplifier element

(57) A magnetic amplifier element (1) including a magnetic member made from a magnetic material (11) and having at least one portion which is made from diamagnetic material (12). Furthermore, in one preferred use at least one director coil (2) is wound around the magnetic amplifier element so that the magnetic amplifier element can be utilized as an antenna. In another preferred use at least one drainage coil is wound around the magnetic amplifier element so that the magnetic amplifier element can be utilized as a noise limiter.

Fig. 1a.

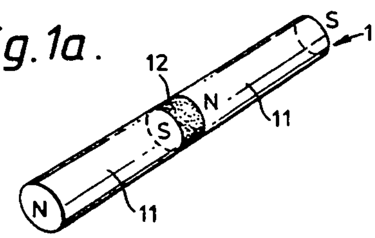
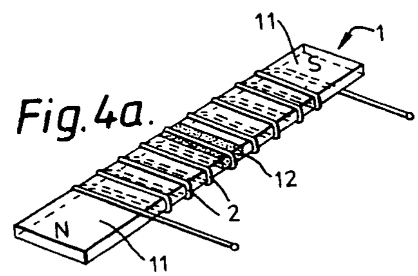


Fig. 4a.



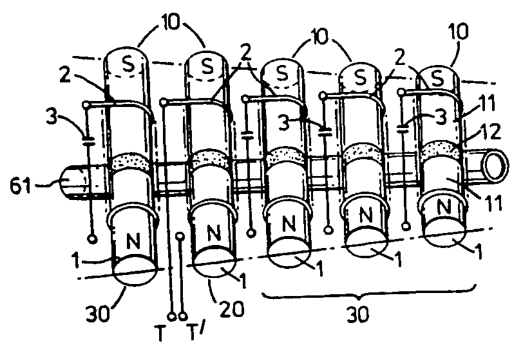


Fig. 7.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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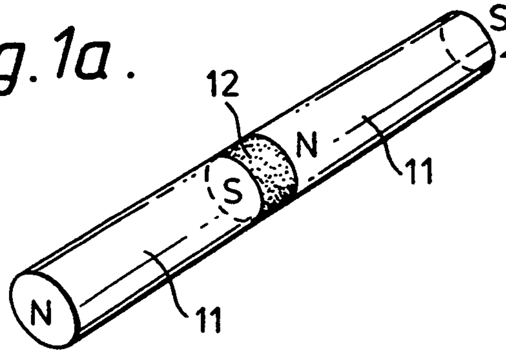
Fig.1a.



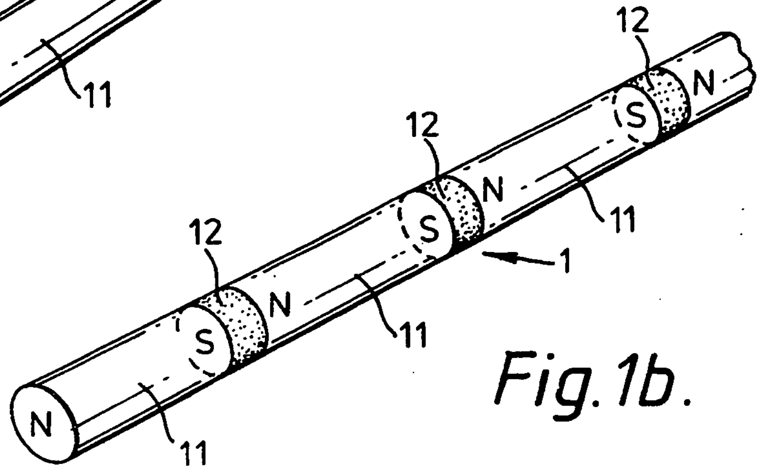
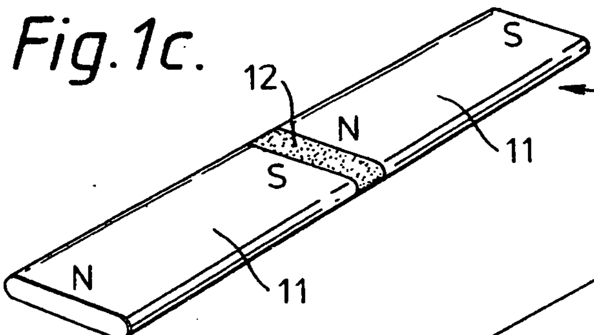


Fig.1b.

Fig.1c.



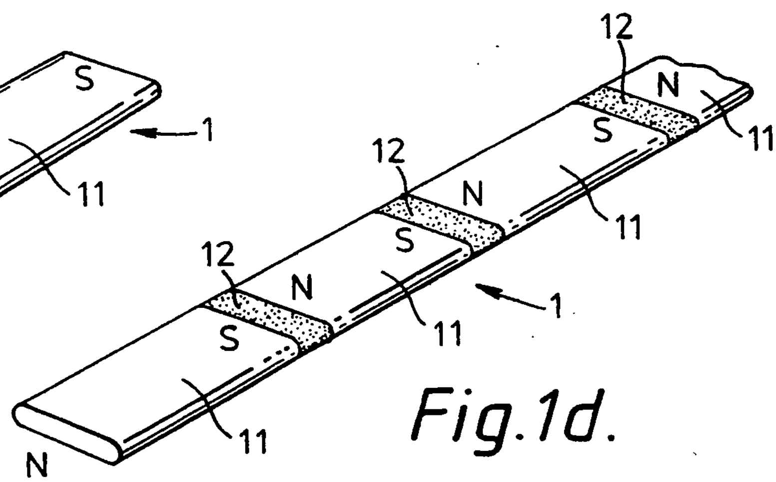
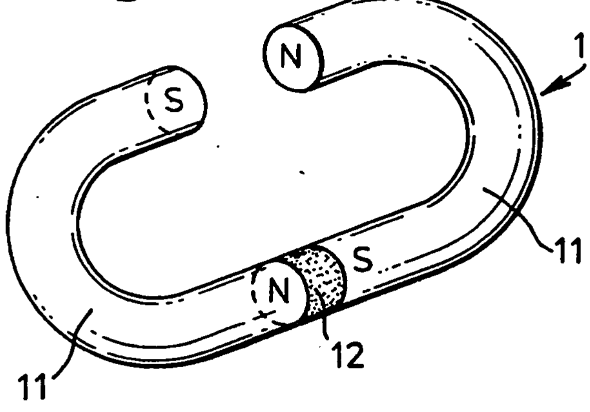


Fig.1d.

Fig. 2a.



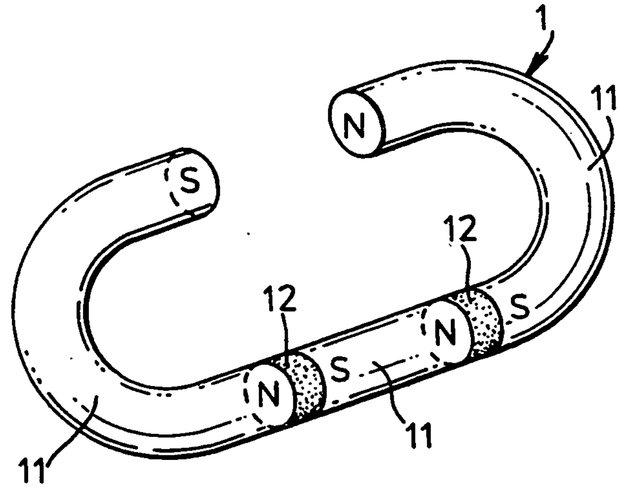


Fig.2b.

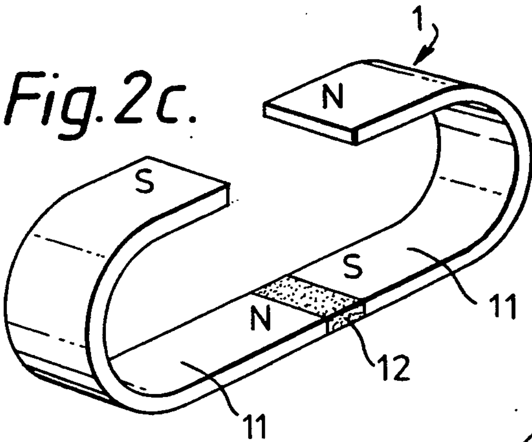


Fig. 2c.

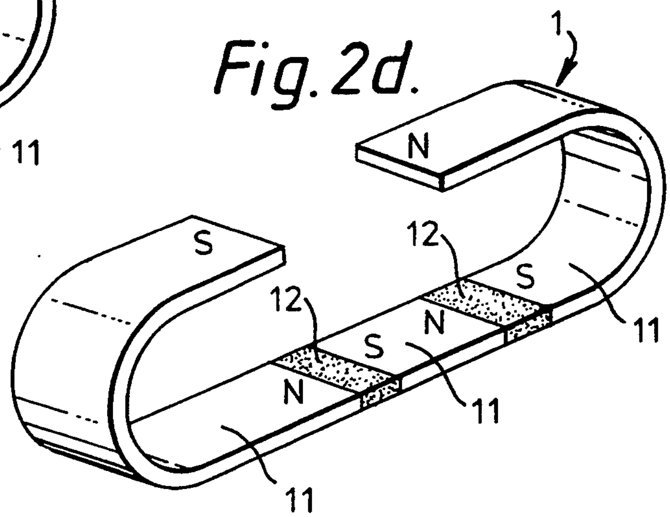


Fig. 2d.

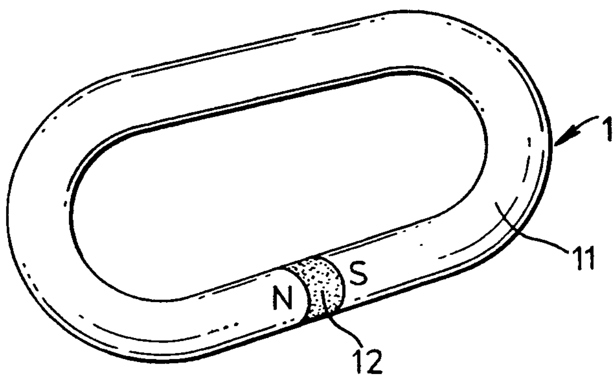


Fig. 3a.

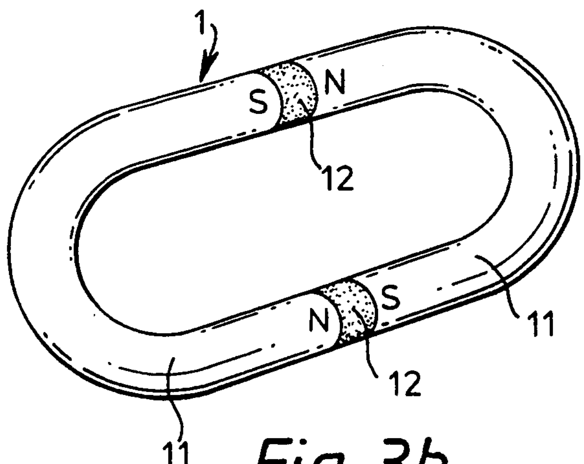


Fig. 3b.

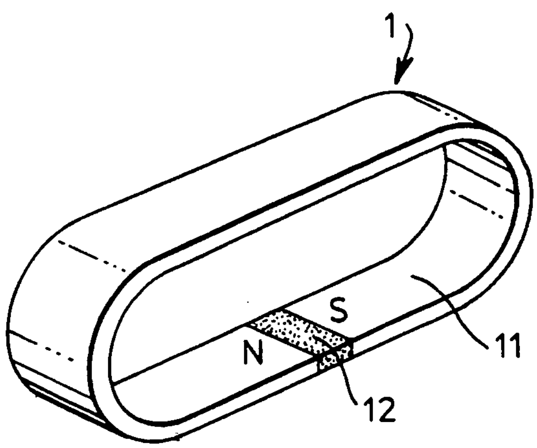


Fig. 3c.

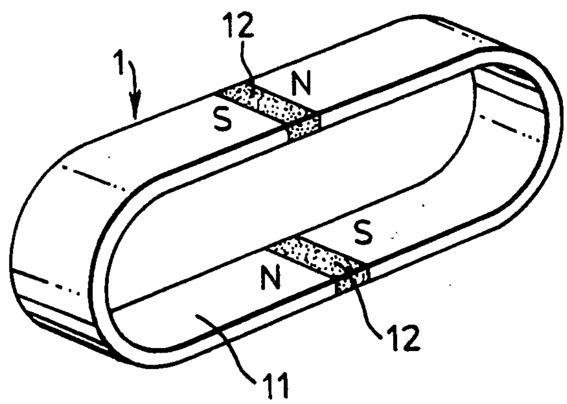
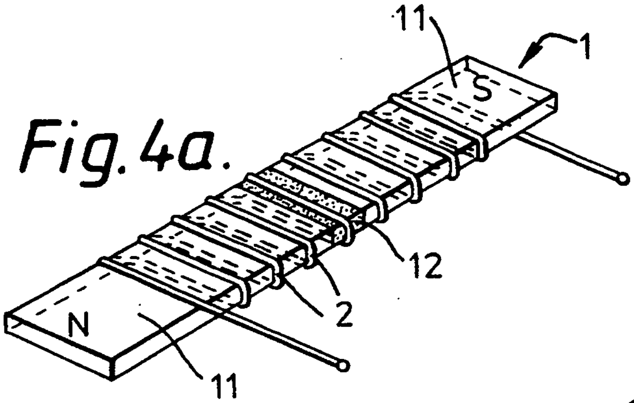


Fig. 3d.

Fig. 4a.



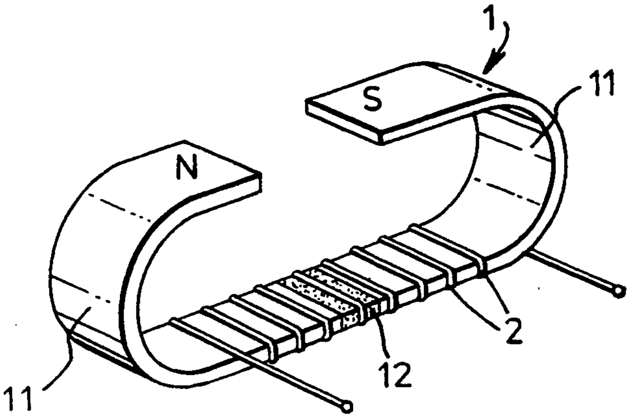
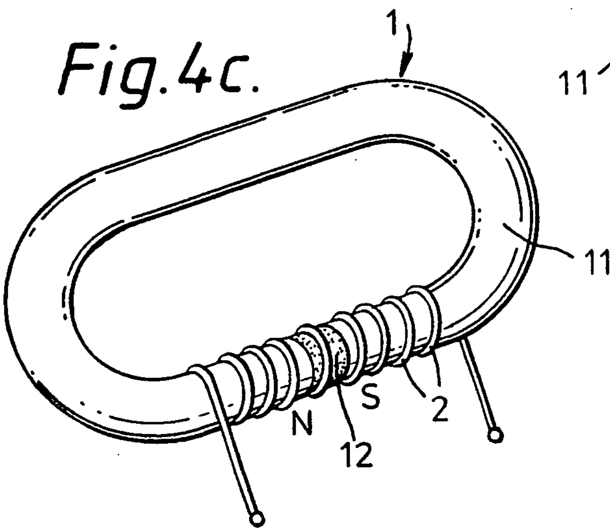


Fig. 4b.

Fig. 4c.



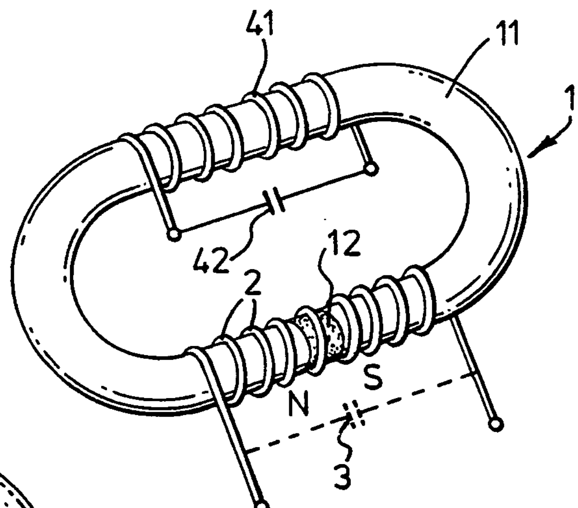


Fig. 4d.

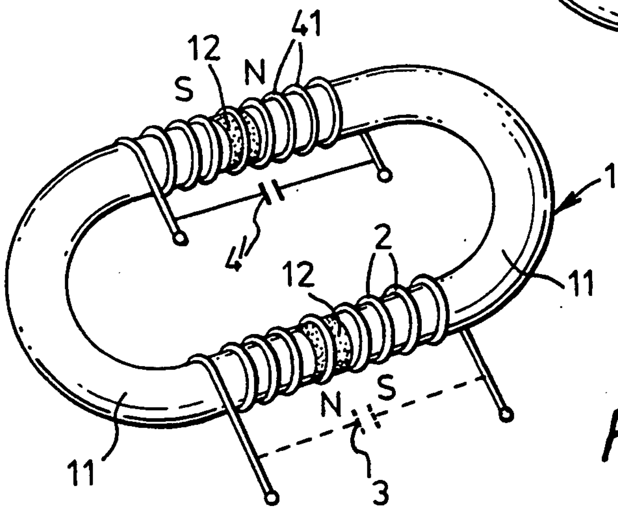
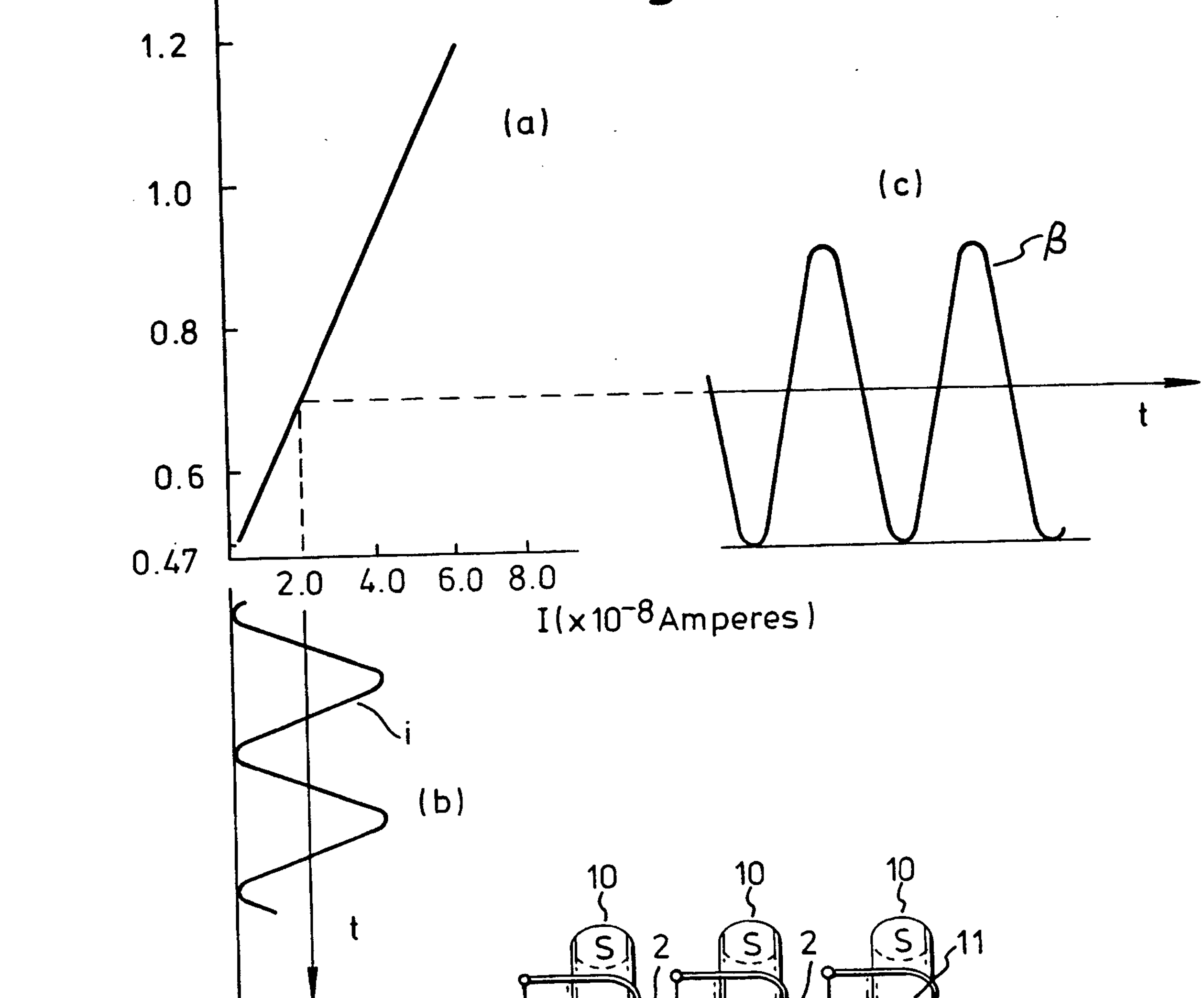


Fig. 4e.

Fig. 5.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(b)
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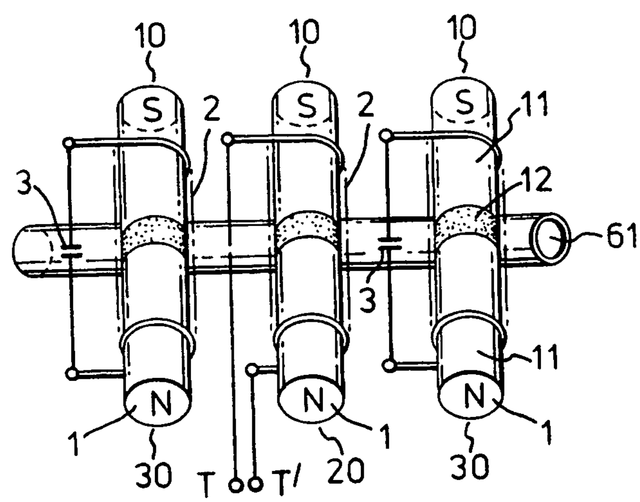
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Fig. 6.

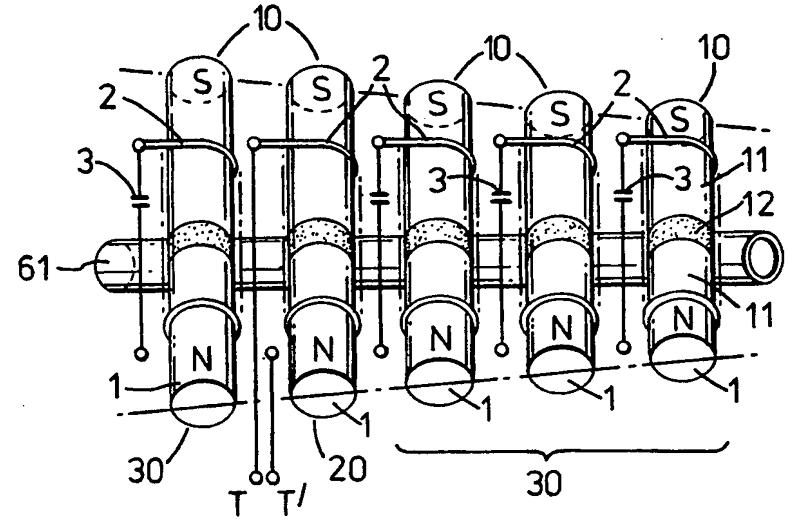


Fig.7.

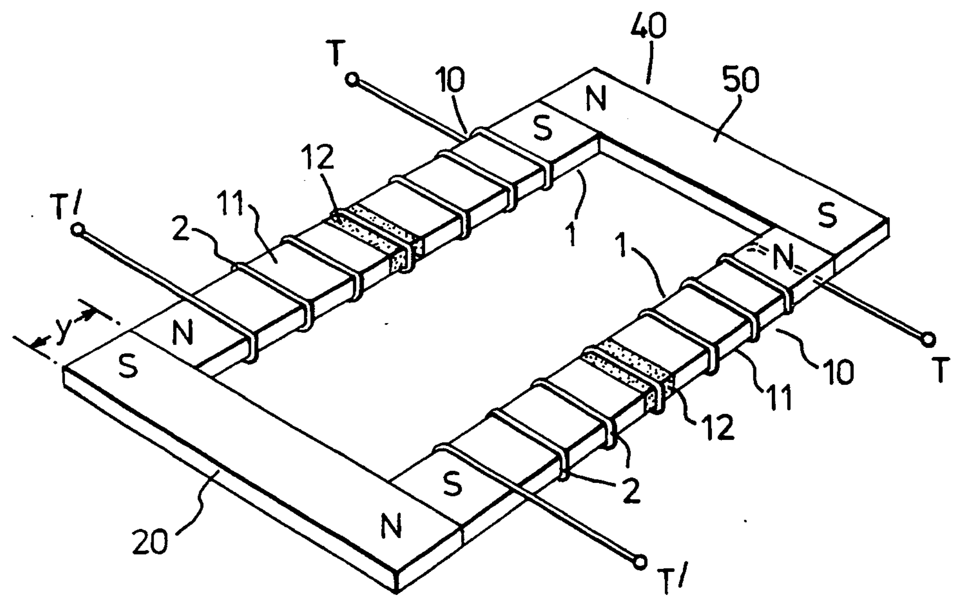


Fig. 8.

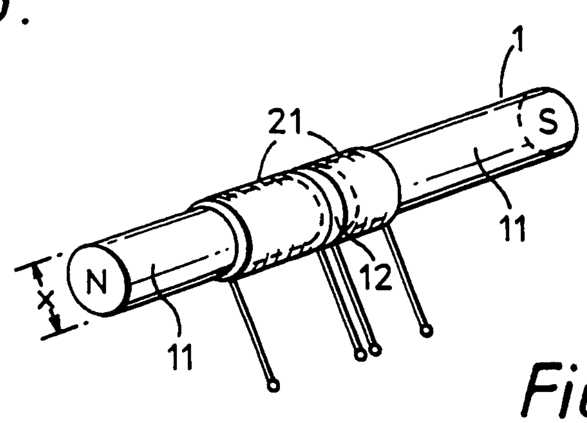


Fig. 9a.

Fig. 9b.

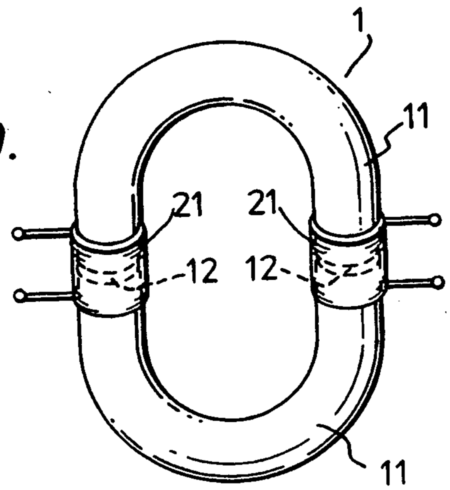
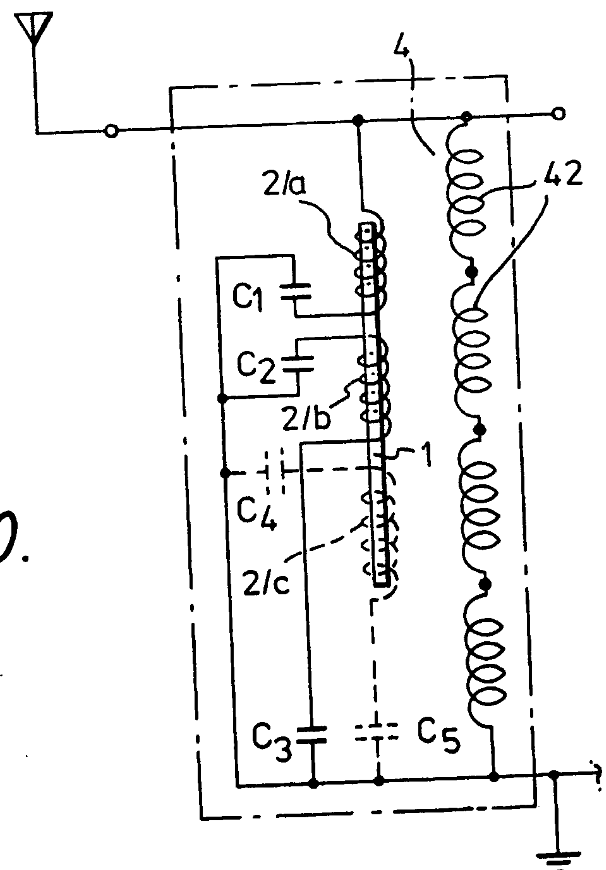


Fig. 10.



SPECIFICATION

A magnetic amplifier element

Background of the invention

1. *Field of invention*

This invention relates to amplifiers and more particularly magnetic amplifier elements.

2. *Prior art*

In the prior art their exists amplifier circuits. Such amplifier circuits are disadvantageous because they require active elements and a source of direct current power.

Summary of the invention

Accordingly it is the general object of the present invention to provide a magnetic element which functions as an amplifier for electro-magnetic waves.

In keeping with the principles of the present invention, the objects are accomplished by a unique magnetic amplifier element. Magnetic amplifier element includes a magnetic material having at least one portion which is made from diamagnetic material. Furthermore, in one preferred use a director coil is wound arround the magnetic amplifier element so that the magnetic amplifier element can be utilized as an antenna, and in another preferred use, at least one drainage coil is wound arround the magnetic amplifier element so that the magnetic amplifier element can be utilized as an noise limiter element.

Brief description of the drawings

The above mentioned principles and objects preservation will become more apparent with reference to the following description taken with the accompanying drawings wherein like elements are given like reference numerals and in which:

Figure 1 is one embodiment of a magnetic amplifier element in accordance with the teachings of the present invention;

Figure 2 is a second embodiment of a magnetic amplifier element in accordance with the teachings of the present invention;

Figure 3 is the third embodiment of a magnetic element in accordance with the teachings of the present invention;

Figures 4(*a*), *4*(*b*), *4*(*c*) and *4*(*d*) illustrate the embodiments of the magnetic amplifier element utilized as an antenna;

Figure 5 is a conceptual figure illustrating the amplifying characteristics of the magnetic element of the present invention used as an antenna;

Figure 6 is an embodiment of an antenna utilizing a plurality of magnetic amplifying elements in accordance with the teachings of the present invention;

Figure 7 is an additional embodiment of an antenna utilizing a plurality of magnetic amplifier elements;

Figure 8 is an additional embodiment of an antenna utilizing a plurality of magnetic amplifier elements.

Figures 9(*a*), *9*(*b*) are embodiments of noise limiter elements utilizing an amplifying element in accordance with the teachings of the present invention;

Figure 10 is circuit diagram illustrating a noise-limiter assembled into VHF band tuning circuit.

Detailed description of the invention

Referring to Figures 1, 2 and 3 shown therein are three different embodiments of a magnetic amplifier element 1 in accordance with the teachings of the present invention. Each of the embodiments has different characteristics are as a result of the differences in shape.

Referring to Figure 1, shown therein is a magnetic amplifier element 1 which consists of a magnetic material 11 which has a diamagnetic material 12 of a particular thickness x interposed into a portion of the magnetic material 11. This magnetic amplifier element 1 of Figure 1 is rod shaped in the direction of the magnetic field of the magnetic material 11.

Referring to Figure 2, shown therein is the case where the amplifier element 1 is C-shaped in the direction of the magnetic field. Referring to Figure 3, shown therein is the case where the shape of the magnetic element is an endless ring in the direction of the magnetic field. From the above described Figures 1, 2 and 3 it should be apparent that magnetic material can be divided up into a plurality of sections by a plurality of diamagnetic materials 12.

In practice, the magnetic material can be any material such as iron, ferites, etc. However, the use of a permanent magnet having a magnetic field density of about 500 gauss is preferred. Also, the length x of the diamagnetic material 12 should be short compared to the length of the magnetic material 11. Furthermore, the diamagnetic material can be any diamagnetic material such as *carbon*, bismuth, copper, gold, silver, mercury, etc. However the use of carbon is preferred. Furthermore, the cross sectional shape of the diamagnetic element may have many shapes. Such shapes may include circular, flat, oblong, etc.

The primary use of the magnetic amplifying element in accordance with the teachings of the present invention is as an amplifying element for electro magnetic waves and can be best utilized in an antenna. If a rod shaped element shown in Figure 1 is substituted for at least one of the wave guide, director elements or

reflector elements of a Yagi antenna, the reception ability of the Yagi antenna improves and the reception ability increases as more of the rod shaped elements are utilized. Furthermore, the amplification function is enhanced when an exciter coil is wound around the element and high frequency excitation applied. In the following antenna embodiments described below, the characteristics and construction will be explained and applicant will attempt to infer and explain as much as possible about the magnetic amplification mechanism of the magnetic amplifying element 1 of the present invention.

Referring to Figure 4(a), 4(b), 4(c) and 4(d), shown therein are an antenna using the magnetic amplifier element and a director coil 2 wound on the magnetic amplifier element 1. When both ends of the director coil 2 are used as input terminals, the magnetic amplifying element 1 becomes a transmitting antenna. When both ends of the growth criteria are used as output terminals, the magnetic amplifier element becomes a receiving antenna.

In practice the director coil 2 should have about 10 turns. Furthermore, the director coil 2 functions as a wave guide and also functions as an exciter of the magnetic amplifier element 1. Furthermore, it is efficient to wind the director coil 2 as closely as possible to minimize the mutual winding effect. Furthermore, the coil 2 may be wound only on the magnetic material 11 but it is preferred to wind at least a portion of the coil 2 on the diamagnetic material 12 and the best results are obtained by winding one turn of the director coil 2 around the diamagnetic material 12. Furthermore, generally as the number of turns of the director coil 2 increases, the amplification increases but as will be explained later the number of turns is related to the frequency characteristics and the directionality of the antenna.

As is apparent from the figures, magnetic materials 11 having different shapes can be utilized. Furthermore the thickness x of the diamagnetic material 12 should be suitably small with respect to the magnetic material 11 to be effective but as stated later, this factor influences the transmission and reception frequency characteristics.

An experiment was formed utilizing a magnetic amplifier element of the following construction:

(1) A high manganese content permanent magnet having a magnetic field density of 470 gauss was used as the magnetic material;

(2) One piece of carbon having a thickness x less than several milimeters was utilized as the diamagnetic material;

(3) The shape of the magnetic amplifier element 1 was flat rod shaped, the width α was about 1.5 cm, and the length was about 6 cm;

(4) The number of turns of the direction coil was 10.

The above described magnetic amplifier element 1 was utilized in a Yaggi antenna having a normal reception sensitivity without the magnetic amplifier element 1 of about 30 decibels. With the above magnetic amplifying element the reception sensitivity was increased to 90 decibels. In addition, a magnetic amplifier element 1 similar to that shown in Figure 1 (d) was utilized in the Yaggi antenna described and again the reception sensitivity was increased similarly. Furthermore, the experiments were performed spanning from the AM band to the UHF band and good reception sensitivity was achieved no matter what frequency ban was utilized.

Even though the applicant has not developed a comprehensive explanatory theory of the operation of the magnetic amplifier element 1 in accordance with the teachings of the present invention, he has attempted to at least experimentally determine the phenomenon as it occurs. It has been experimentally determined that increased amplfication effects occur. In addition, during the transmission or reception of electromagnetic waves, the magnetic field density of the magnetic material becomes usually high. For example, the magnetic field density of a magnetic material 11 which is normally 470 gauss may exceed 1,000 gauss. Furthermore, when viewing the characteristics of the magnetic element 1, it is apparent that a transmitted or received wave causes an extremely small electric current to flow in the direct coil 2. This extremely small electric current excites the magnetic amplifier element 1 and the magnetic field density increases to a great extent. This situation is illustrated in Figure 5 (a). It has been determined experimentally that an increase in the electric current 1 of the order of 10^{-8} amperes causes an increase in the magnetic field density B in the order of 10^2 gauss. Furthemore, as shown in Figure 5(b), an atmospheric electromagnetic wave received by the director coil 2 gives rise to an extremely weak electric current i. This current in director coil 2 excites the magnetic amplifier element 1 and following the amplification relationship shown in Figure 5(a), a magnetic field is produced and this magnetic field induces a directly amplified electric current in the director coil 2. Furthermore, the field data also causes amplification of the atmospheric electromagnetic waves and since the atmospheric waves are amplified by feedback in the director coil 2, an extremely high transmission or reception variety is achieved.

Additional experiments were performed using a plurality of magnetic amplifier elements 1 and such experiments will be described in relation to Figure 6 and 7. In the Figures, a plurality of antenna units 10 are utilized. Each of the antenna units 10 is a rod shaped magnetic amplifier 1. The antenna units 10 are arranged in parallel and are maintained at a fixed separation by being fastened to an insulator shaft 61. In the situation using circular rod shaped amplifier elements as shown in Figure 6, the amplification increases approximately 5 times that of one element. That is to say, if two elements are utilized, the amplification is about 2.5 times that of one element. In addition, if three elements are used, the amplification is about 5 times greater than that of one element.

Referring to Figure 7, shown therin as another embodiment of antenna using a plurality of antenna units

10, wherein the magnetic poles of the magnetic amplifying element 1 point in the same direction and which utilize four or more antenna units 10. Also as shown in Figure 7 the length of the magnetic amplifier elements 10 decreases from one end to the other. For best results either the longest antenna until 10 or the second longest antenna unit 10 is to be used as the transmitter-receiver element 20, but the choice of the second longest one gives the best stability. The relation between the lengths of the magnetic amplifier 1 is substantially the same as the relation between the lengths of the elements of an ordinary Yagi antenna.

By experimentation the inventor has determined that better results are obtained by using four or five antenna units 10 as shown in Figures 7 having the second longest antenna unit 10 as the transmitter-receiving element 20 than an antenna using four or five magnetic amplifier elements 1 of the same length as shown in Figure 6. That is to say, in this case, each of the antenna units displays its own amplification function while mutually influencing each other and increasing the extent of amplification in somewhat the same manner as described in Figure 6.

Referring to Figure 8, shown therein is an another embodiment of an antenna using a plurality of antenna units 10. The antenna of this embodiment is formed by arranging magnetic amplifying elements 1 into a endless rectangular frame or loop 40 as is described below. In particular, two of the above-described antenna units 10 are provided so that the magnetic fields of the antena units 10 are oriented in opposite direction and the longitudinal axes of the antenna units 10 are parallel to each other. Two magnetized coupling members 50 are laterally installed at both ends of the two antenna units 10 so that the magnetic lines of force of the coupling magnetic members 50 connect perpendicularly with the magnetic lines of force of the magnetic amplifying elements 1.

If the antenna is constructed as described above, the magnetic lines of force of the two magnetic amplifying elements 1 circle the endless rectangular frame 40. As a result, the two magnetic amplifying elements 1 are connected in series.

It has been determined that it is possible to obtain an antenna whose degree of amplification is much higher than that of one utilizing a single antenna unit 10.

Described below are measurements for an antenna in accordance with the teachings of the above embodiment which describes the conditions listed below.

Conditions

Magnetic parts 11 and 50:	Permanent magnets with a magnetic flux density of approximately 470 gauss
Diamagnetic parts 12:	Carbon (thickness (χ): approximately 3 mm)
Director coils:	12 turns
Size:	Length 7.3 cm; width 4 cm

Width (Y) of magnetic amplifying elements 1 and magnetic members 20: 1.2 cm

Measurement results

A receiving sensitivity of 180 decibels and an extremely low ghost range were obtained in a weak electric field region in which the receiving sensitivity of a Yagi antenna was only 30 decibels.

From experiments the operation and characteristics of the three types of antennas are explained herein below.

Regardless of whether a single antenna unti 10 or a plurality of antenna units 10 are used, the cross sectional shape of the magnetic amplifier 1 has a large influence on the transmission-reception sensitivity. If conditions (for example length, number of pieces of diamegnetic material, number of coil winders, etc.) are the same and if the diameters β of the circle or the width α of the flat cross section are the same (as shown in Figure 1) and both poles are separated by an air gap (i.e., in the case of a rod shaped or C-shaped element 1), the flat shape is most effective.

If conditions are the same, sensitivity increases in the order rod shaped, endless ring or rectangular-shaped, c-shaped. For the case of an endless ring-shaped or rectangular-shaped element 1 or 40, if two director coils 2 are wound as shown in Figures 4(d), 4(e), and 8, the transmission reception sensitivity increases. Furthermore, the antenna utilizing the magnetic amplifer element of the present invention not only exhibits good amplification characteristics but also the antenna posesses exceptional directivity and the frequency characteristics can be freely chosen. The directional angle of an antenna utilizing the magnetic amplification element of the present invention is less than 40 degrees as measured experimentally.

Factors influencing the transmission-reception frequency characteristics are considered to be the thickness of x of the diamagnetic material 12 and the number of turns of coil 2. As the thickness of the diamagnetic material 12 increases, the transmission-reception characteristics improve for high frequency signals and as the number of coil windings decrease, the transmission-reception characteristics also improve for high frequency signals.

However connecting a low capacity frequency tuning condenser 3 to both ends of the direct coil 2 and changing this capacitance permits changing of the frequency characteristics.

If the magnetic amplifier element 1 having such a construction and characteristics as described above is used as described below, while it naturally possesses a high-frequency amplification function, it may also function as a good noise limiter.

The noise limiter of the present invention is provided by winding one or more drainage coils 21 around the

above-described magnetic amplifier element 1.

Feferring to Figures 9(a) 9(b) shown therein are two embodiments in the present noiselimiter. Figure 9(a) generally shows the case using a rog shaped magnetic amplifier element 1 having one piece of diamagnetic material 12 and having a total length of several centimeters. Figure 9(b) illustrates the case of an endless ring as magnetic amplifier element 1 having two pieces of diamagnetic matelial 12.

Figure 10 is circuit diagram illustrating a noise limiter assembled into the tuning circuit 4 of the recever. Figure 10 is examples applicable to receivers for the VHF band. One of the drainage coils 2a carries both excitation and noise currents, and is connected in parallel with the tuning circuit 4, while the other drainage coils 21b, 21c,... have both ends grounded. As the number of grounded drainage coils 21b, 21c,... increases the noise drainage effect increases. Condensers C_1,C_2, C_3,... are introduced to permit adjustment of the tuning circuit 3 used in present day receivers. If the tuning characteristics are designed so as to match the noise-limiter element, such as condensers are unnecessary. Also, coils 42 are tuning coil.

From experimentation it has been determined that the noise-limiting function of the noise-limiter element of the present invention is somewhat better than the prior art noise limiter circuit which uses a diode. The noise limiter element of the present invention reduces the noise 40-50%. Also, the noise limiter of the present invention possess an amplification ratio of approximately 1.5 - 2 times greater than that of a high-frequency amplification circuit using transistors.

As explained above, the magnetic amplifier element of the present invention is considered to have the characteristics shown in Figure 5. In other words a small change in electric current flowing through the excitation coil wound around the magnetic element 1 causes a large change in magnetic field density. Therefore, it may be used as an antenna, etc. which posesses amplification ability or in various high frequency elements or circuits. Also, it may function as a good noise-limiter as explained above.

CLAIMS

1. A magnetic amplifier element comprising a magnetic member made from magnetic material and at least one portion of said magnetic member being made from diamagnetic material.

2. A magnetic amplifier element according to claim 1 wherein the magnetic member is rod shaped in the direction of the magnetic field.

3. A magnetic amplifier element according to claim 1 wherein the magnetic member is C-shaped in the direction of the magnetic field.

4. A magnetic amplifier element according to claim 1 wherein said magnetic member is endless ring shape in the direction of the magnetic field.

5. A magnetic amplifier element according to claim 1, 2, 3 or 4 wherein the cross sectional shape of the magnetic member in a direction perpendicular to the magnetic field is flat.

6. A magnetic amplifier element according to claim 1, 2, 3 or 4 wherein the magnetic material is a permanent magnet.

7. A magnetic amplifier element according to claims 1, 2, 3 or 4 wherein the diamagnetic material is carbon.

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